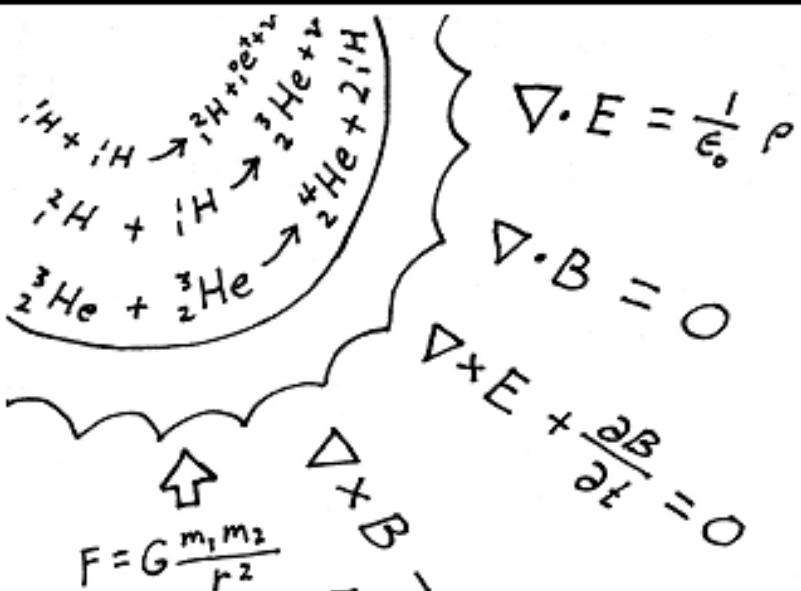


# Nature's benefits to people: National & provincial significance of the Eastern Slopes

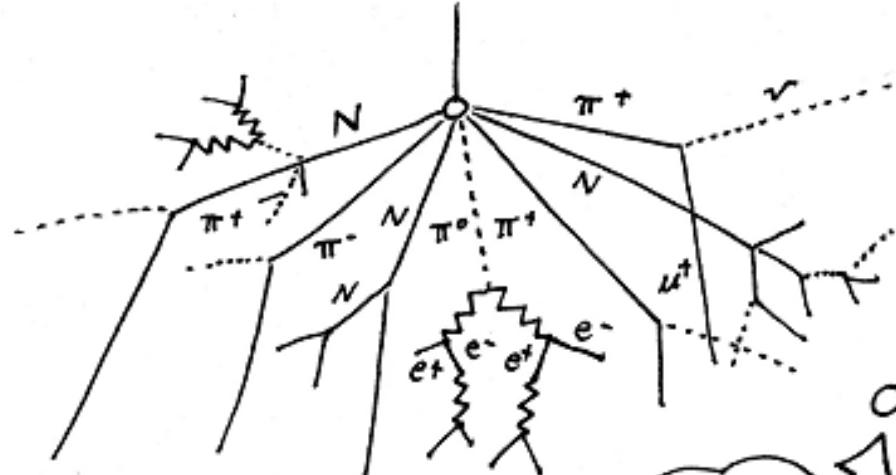
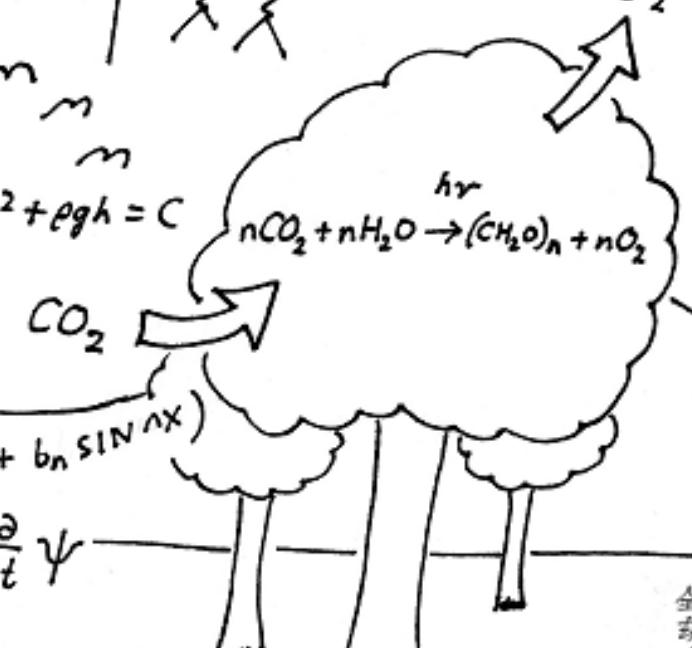
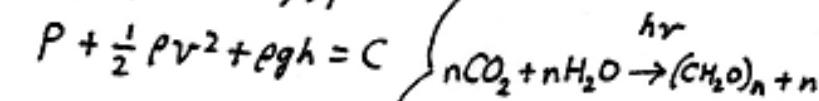
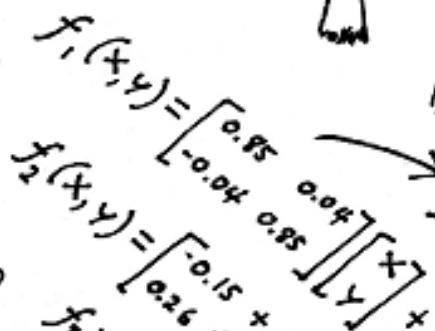
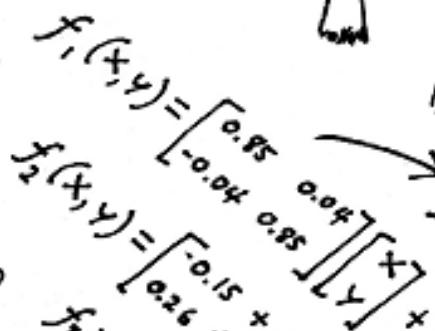
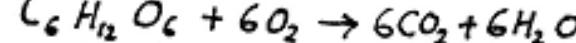
Dr. Aerin Jacob, Y2Y  
24 June 2021





$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = 8\pi G T_{\mu\nu}$$

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = 8\pi G T_{\mu\nu}$$



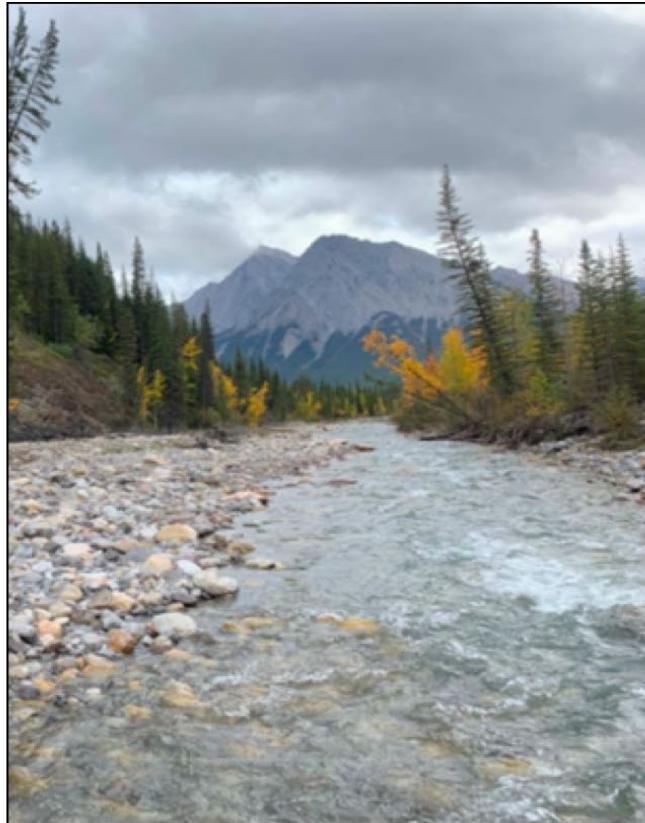
# People get all kinds of *benefits from nature* ("ecosystem services")



# Model and map three key benefits that people get from nature across Canada (and Alberta)



Carbon  
storage



Freshwater



Nature  
Recreation



THE UNIVERSITY  
OF BRITISH COLUMBIA



Carleton  
UNIVERSITY



McGill  
UNIVERSITY



IP Publishing DevRes Lett. 16 (2021) 014008 https://doi.org/10.1080/1748-9236abc.121

ENVIRONMENTAL RESEARCH LETTERS

LETTER

Identifying key ecosystem service providing areas to inform national-scale conservation planning

Matthew G E Mitchell<sup>1</sup>\*, Richard Schuster<sup>2</sup>, Aerin L Jacob<sup>3</sup>, Dalal E L Hanna<sup>4</sup>, Camille Ouellet Dallaire<sup>5</sup>, Cara Raudsepp-Hearne<sup>6</sup>, Elena M Bennett<sup>7</sup>, Bernhard Lehner<sup>8</sup> and Kai M A Chan<sup>9</sup>

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<sup>2</sup> Faculty of Land and Food Systems, University of British Columbia, 248-2357 Main Mall, Vancouver, British Columbia V6T 1Z4, Canada

<sup>3</sup> Department of Biology, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario, Canada, K1S 5B6

<sup>4</sup> Willowton to Yukon Conservation Initiative, 200-1350 Raybey Avenue, Canmore, Alberta, Canada, T1W 1P6

<sup>5</sup> Department of Natural Resource Sciences, McGill University, 2111 Lakeshore Road, Sainte-Anne-de-Bellevue, Quebec, H9X 3V9 Canada

<sup>6</sup> Department of Geography, McGill University, 805 Sherbrooke Street West, Montreal, Quebec, H3A 0B9 Canada

<sup>7</sup> Sustainability Science Lab, McGill University, 845 Sherbrooke Street West, Montreal, Quebec, H3A 0G4 Canada

<sup>8</sup> Bieler School of Environment, McGill University, 2111 Lakeshore Road, Sainte-Anne-de-Bellevue, Quebec H9X 3V9, Canada

<sup>9</sup> E-mail: matthew.mitchell@ubc.ca

Keywords: ecosystem services, conservation, protected areas, carbon, freshwater, recreation, Canada

Supplementary material for this article is available [online](#)

Abstract

Effectively conserving ecosystem services in order to maintain human well-being is a global need that requires an understanding of where ecosystem services are produced by ecosystems and where people benefit from these services. However, approaches to effectively identify key locations that have the capacity to supply ecosystem services and actually contribute to meeting human demand for those services are lacking at broad spatial scales. We developed new methods that integrate measures of the capacity of ecosystems to provide services with indicators of human demand and ability to access these services. We then identified important areas for three ecosystem services currently central to protected area management in Canada—carbon storage, freshwater, and nature-based recreation—and evaluated how these hotspots align with Canada's current protected areas and resource development tenures. We find that locations of ecosystem service capacity overlap only weakly (27–36%) with actual service providing areas (incorporating human access and demand). Overlapping hotspots of provision for multiple ecosystem services are also extremely limited across Canada; only 1.2% (~56 000 km<sup>2</sup>) of the total ecosystem service hotspot area in Canada consists of overlap between all three ecosystem services. Canada's current protected area network also targets service capacity to a greater degree than provision. Finally, one-half to two-thirds of current ecosystem service hotspots (54–66%) overlap with current and planned resource extraction activities. Our analysis demonstrates how to identify areas where conservation and ecosystem service management actions should be focused to more effectively target ecosystem services to ensure that critical areas for ecosystem services that directly benefit people are conserved. Further development of these methods at national scales to assess ecosystem service capacity and demand and integrate this with conventional biodiversity and conservation planning information will help ensure that both biodiversity and ecosystem services are effectively safeguarded.

1. Introduction

opportunity to achieve this by ensuring that conservation actions target both biodiversity and ecosystem services. The 2050 vision of the Convention on Biological Diversity (CBD 2010) and the 2020 Aichi

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Mitchell et al. (2021) *Environmental Research Letters*.



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**CBC**



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Government



Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada

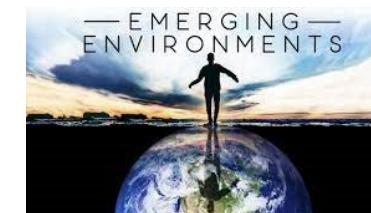
**THE GLOBE  
AND MAIL**

**» TORONTO STAR «**

**msn**

**NATIONAL POST**

**THE  
CANADIAN  
PRESS**



**THE CONVERSATION**



**Canada**



**Pathway to Canada Target 1**  
En route vers l'objectif 1 du Canada



**THE CITY OF  
CALGARY**



**Girl Guides  
of Canada**  
**Guides  
du Canada**

**ON AIR • 96.9 FM  
CJRW  
ON DEMAND • CJRW.COM**



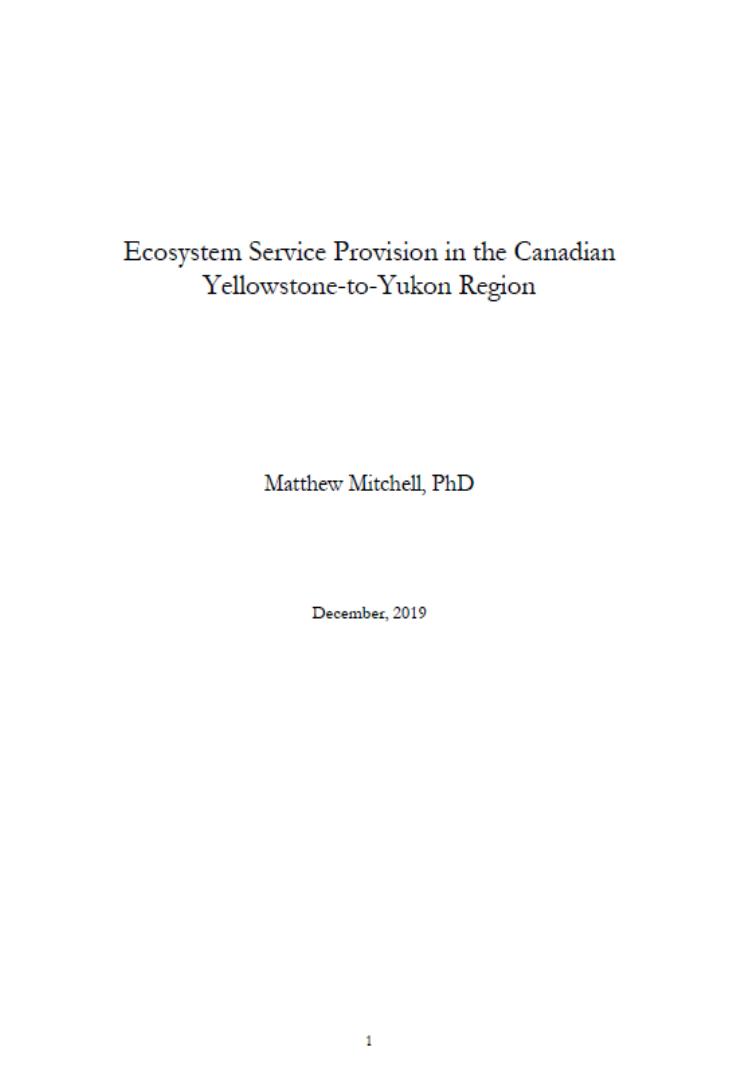
**IUCN | Canadian  
Committee**



**CPCIL**  
CANADIAN PARKS COLLECTIVE  
FOR INNOVATION AND LEADERSHIP

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POUR L'INNOVATION ET LE LEADERSHIP

**FIRST NATIONS  
LAND MANAGEMENT  
RESOURCE CENTRE**

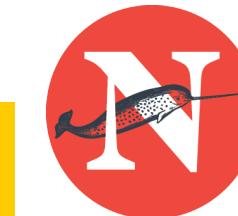


Mitchell (2019) Technical report  
for Y2Y about BC, AB, YT, & NWT.

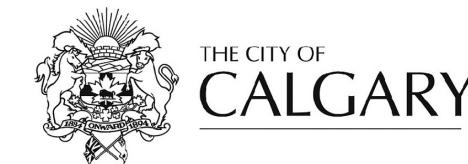


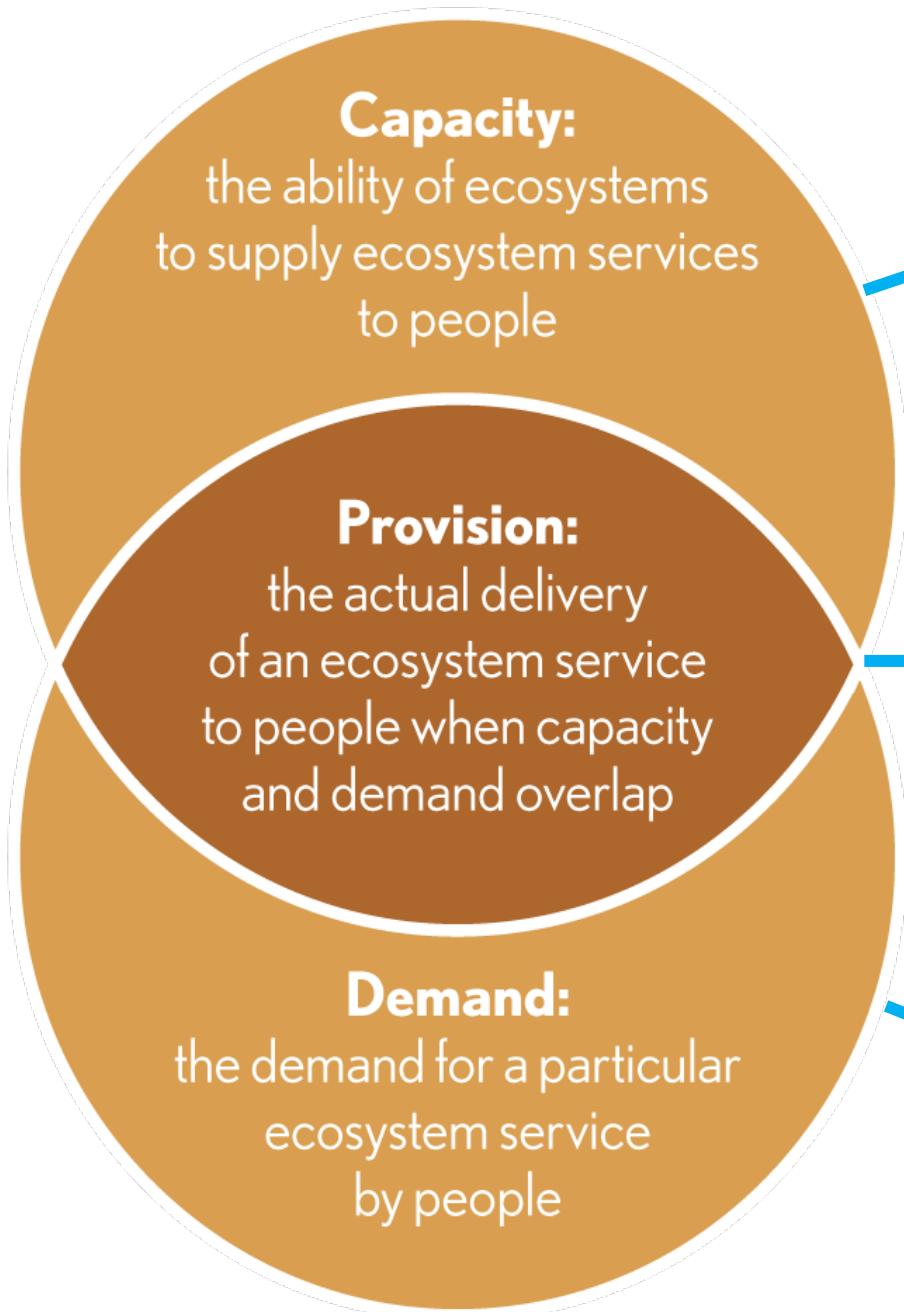
Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada

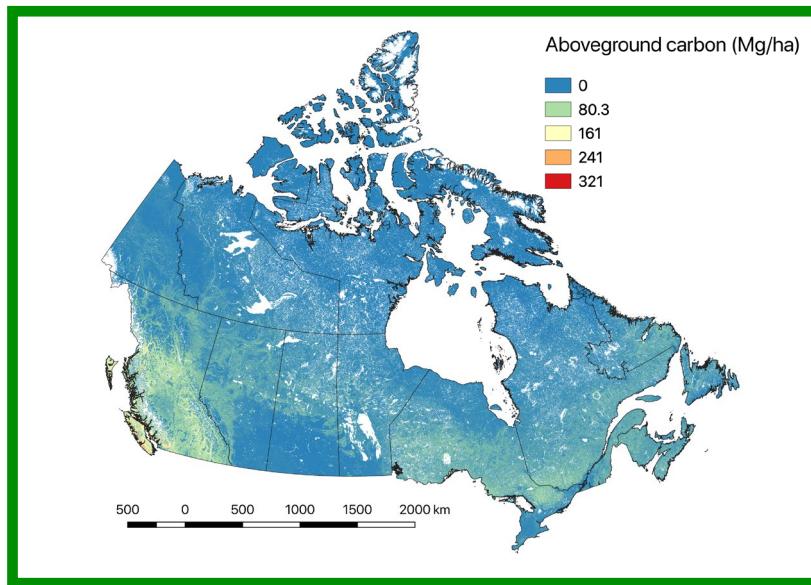


Pathway to Canada Target 1  
En route vers l'objectif 1 du Canada



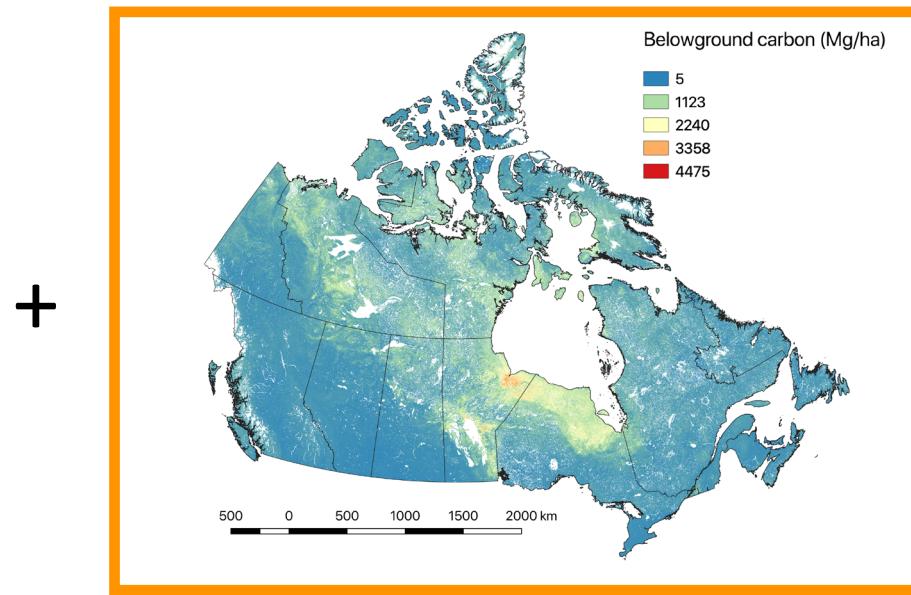


# CARBON: ABOVEGROUND + BELOWGROUND = PROVISION



Aboveground carbon

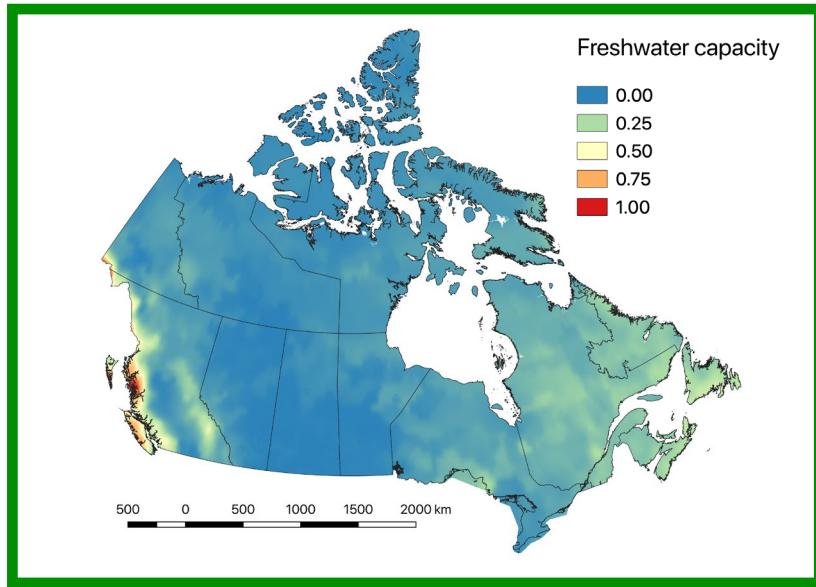
- National Forest Inventory
- Live and dead tree biomass



Belowground carbon

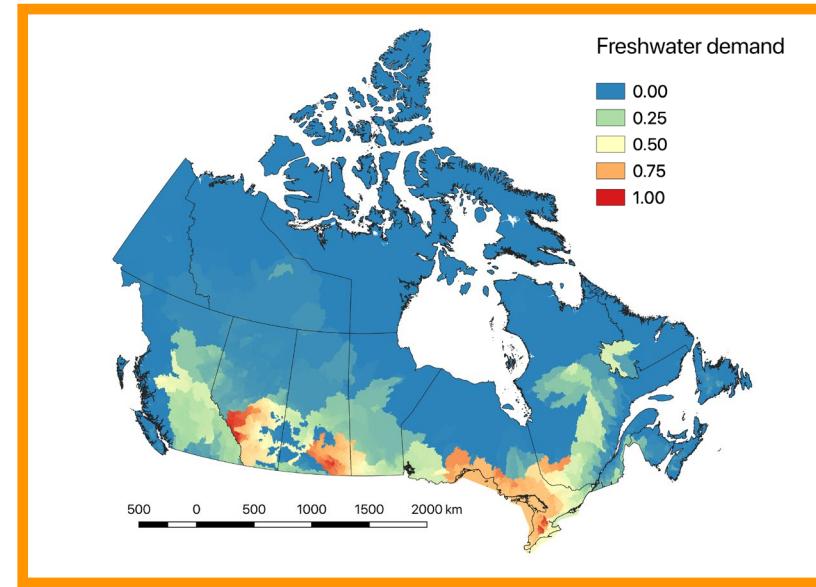
- SoilGRIDS data (0-1 m deep)
- Modelled from soil sample data

# FRESHWATER: CAPACITY $\times$ DEMAND = PROVISION



## Freshwater capacity

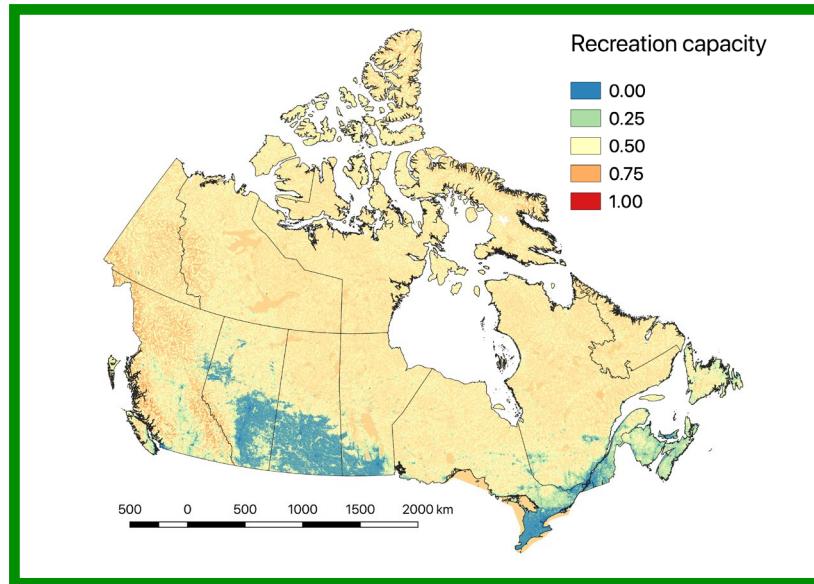
- Estimated water runoff
- HydroSHEDS data
- Estimated from WaterGAP model



## Freshwater demand

- Relative downstream demand
  - area of agricultural land
  - # of dams
  - # of settlements > 100 people
  - # industrial facilities & thermal power stations

# RECREATION: CAPACITY $\times$ ACCESS/DEMAND = PROVISION



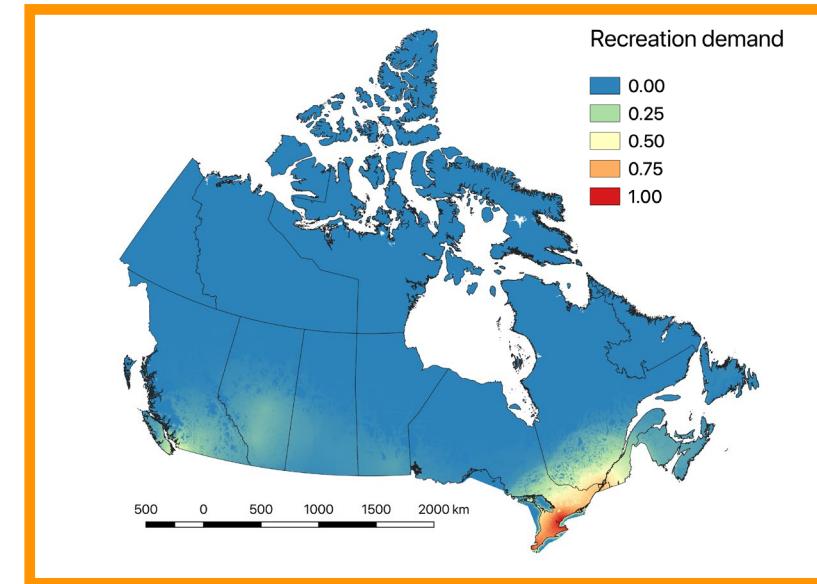
Nature-based recreation capacity

## Positive

- Land cover naturalness
- Proximity to water
- Mountains/ruggedness

## Negative

- Road density
- Population density



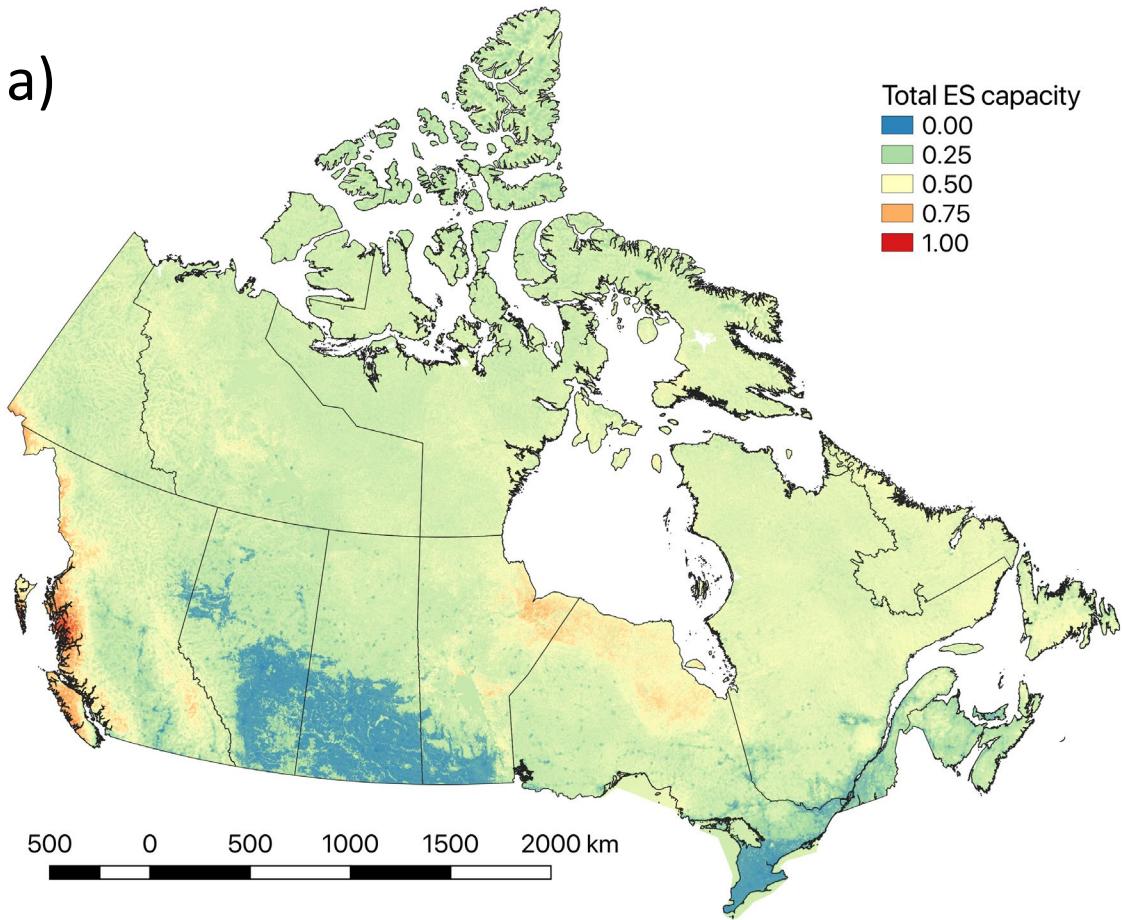
Nature-based recreation access/demand

- Distance to road within 5 km
- Population density within 500 km (including US populations)

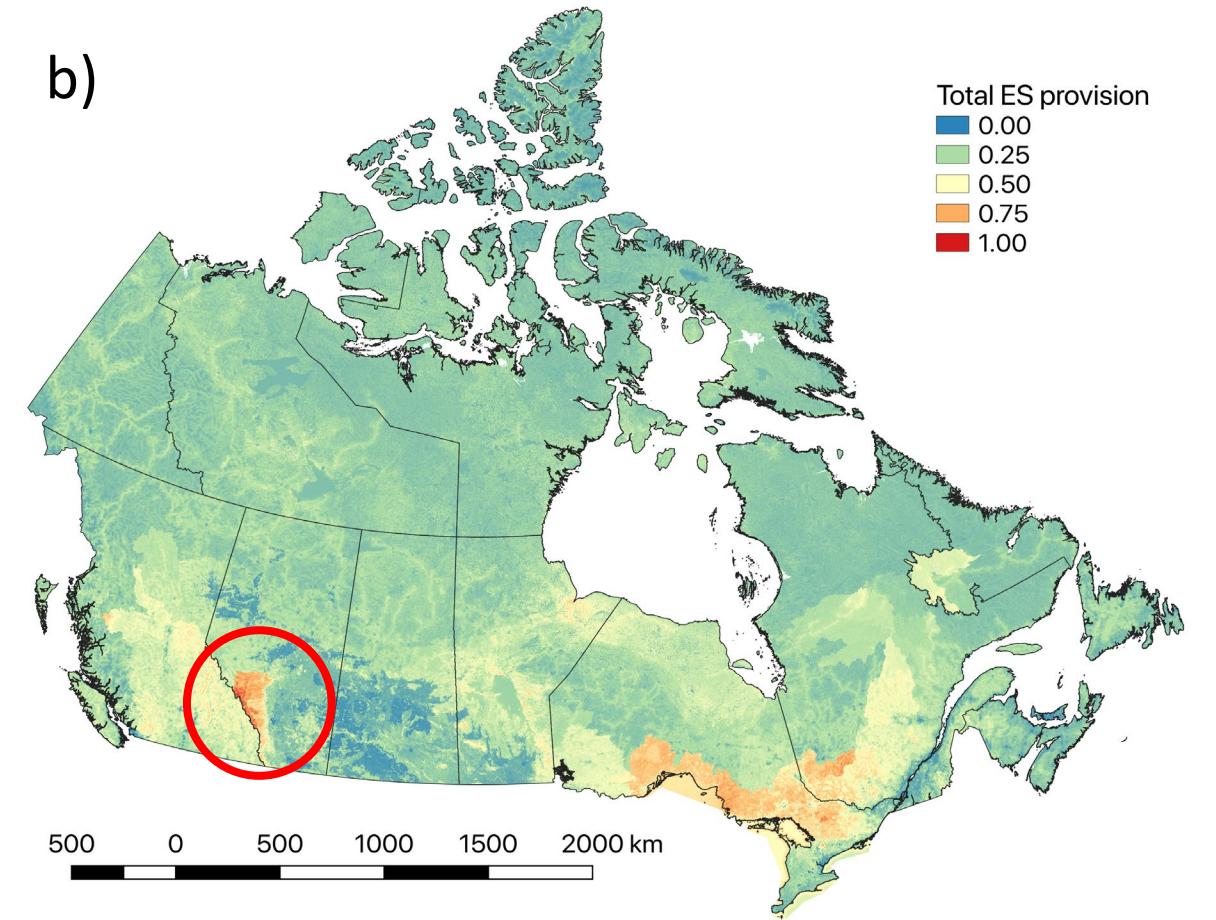
1

Where ecosystems a) can provide benefits are often not the same places where they b) actually do provide benefits to the most people

a)



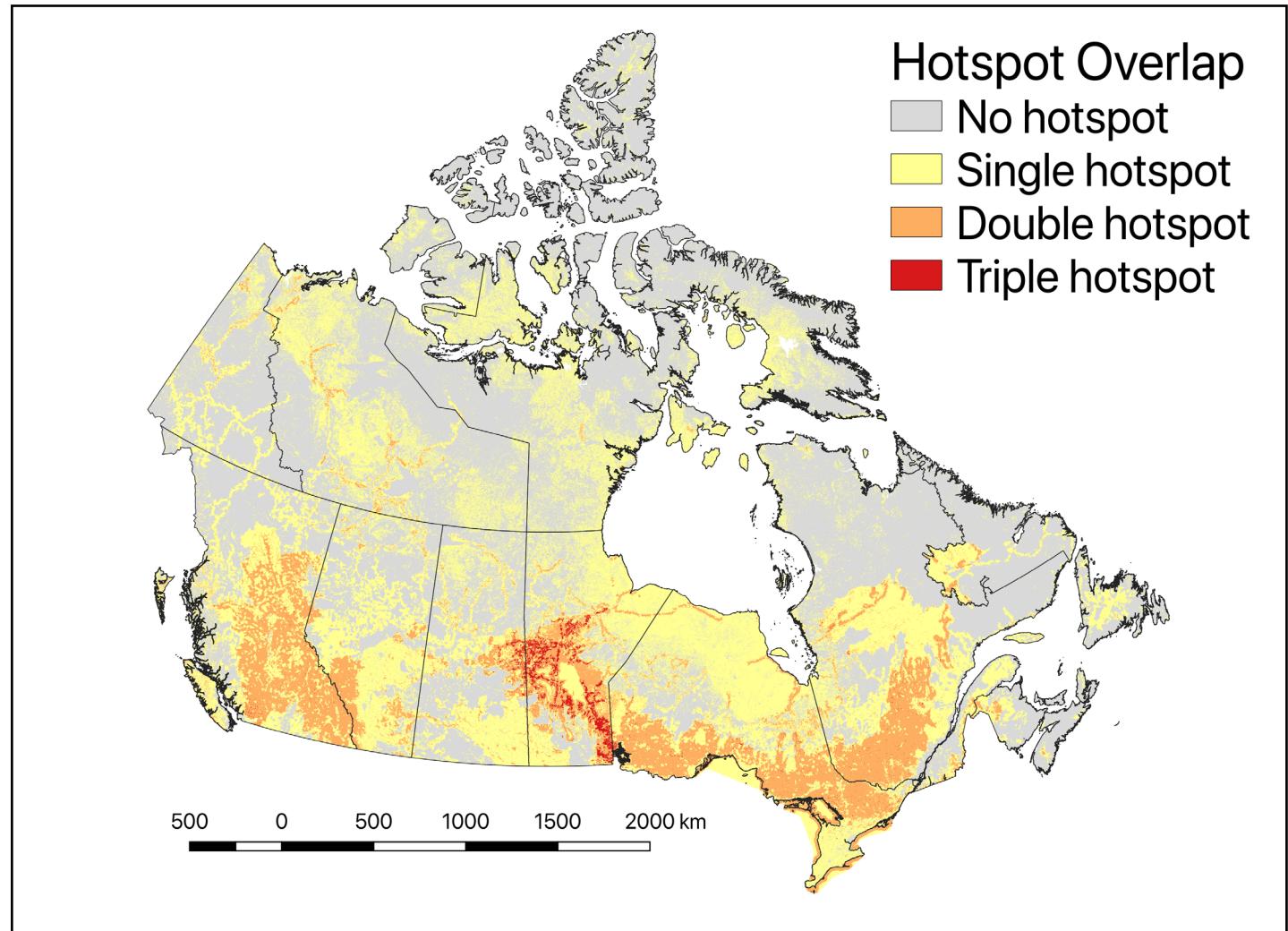
b)



2

Most of the places where people get a lot of one benefit (“hotspot” = top 20% of one benefit) do not overlap with each other.

Places that are **orange** or **red** are really important → high amounts of 2 or 3 key benefits to people.



**Capacity:** Alberta is a relatively dry province with little water.

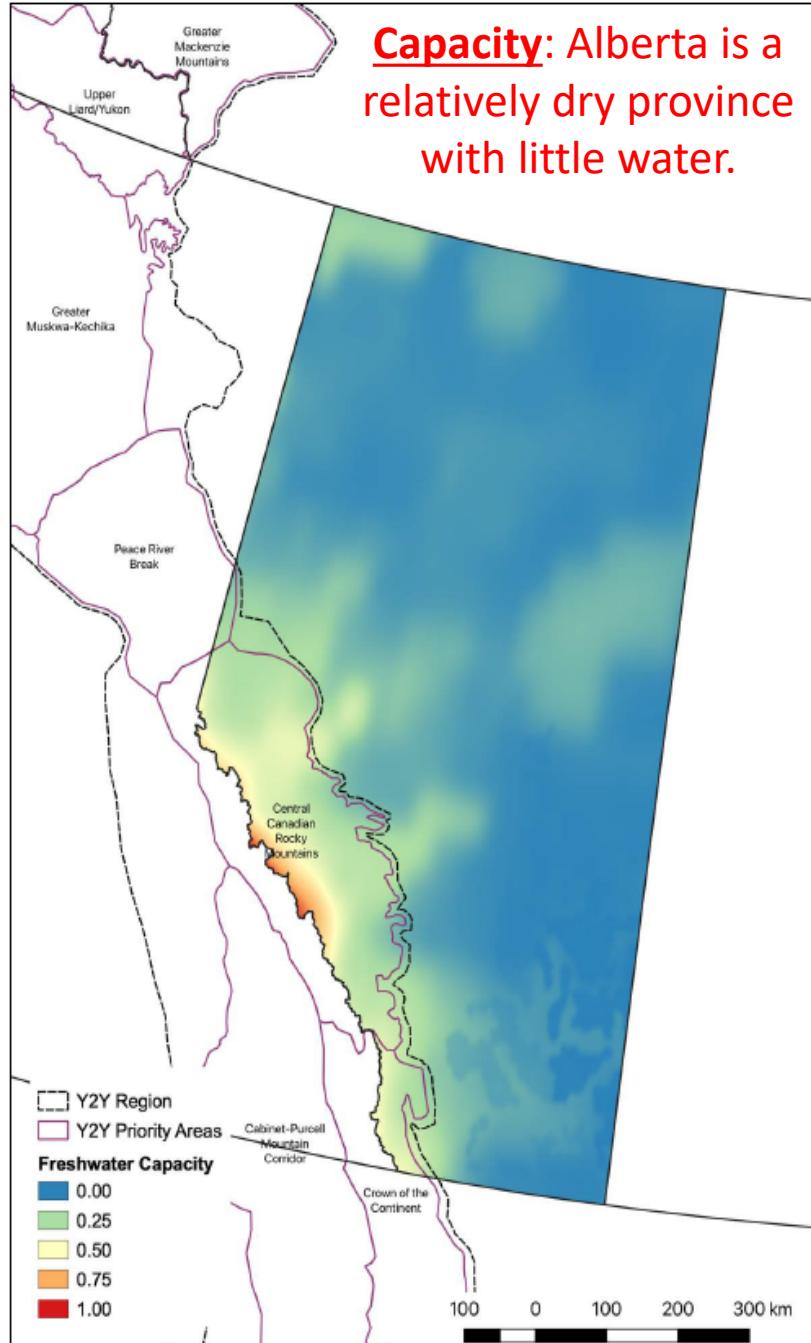


Figure 24. Freshwater capacity importance in Alberta.

**Demand:** Eastern Slopes water is already needed & used, far downstream.

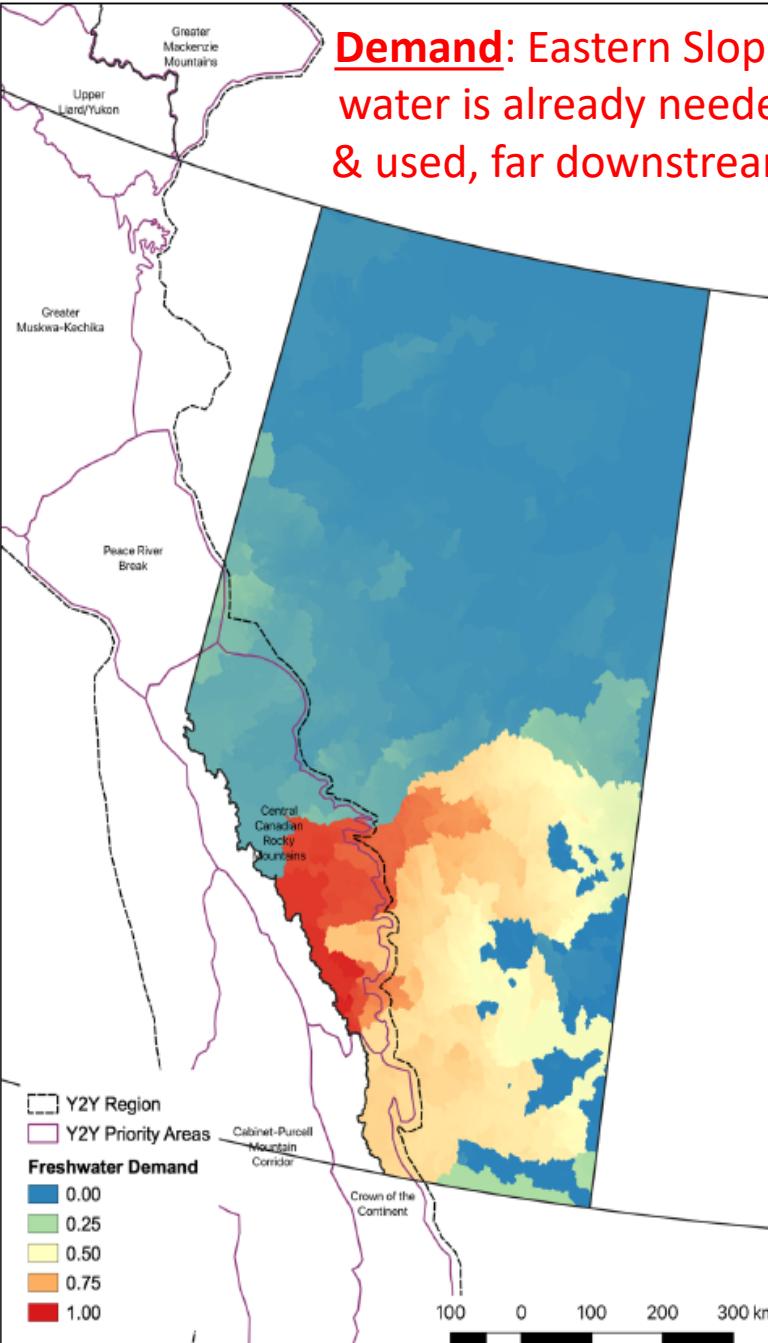


Figure 25. Freshwater demand importance in Alberta.

**Provision:** Be extremely careful with the few places that actually provide water.

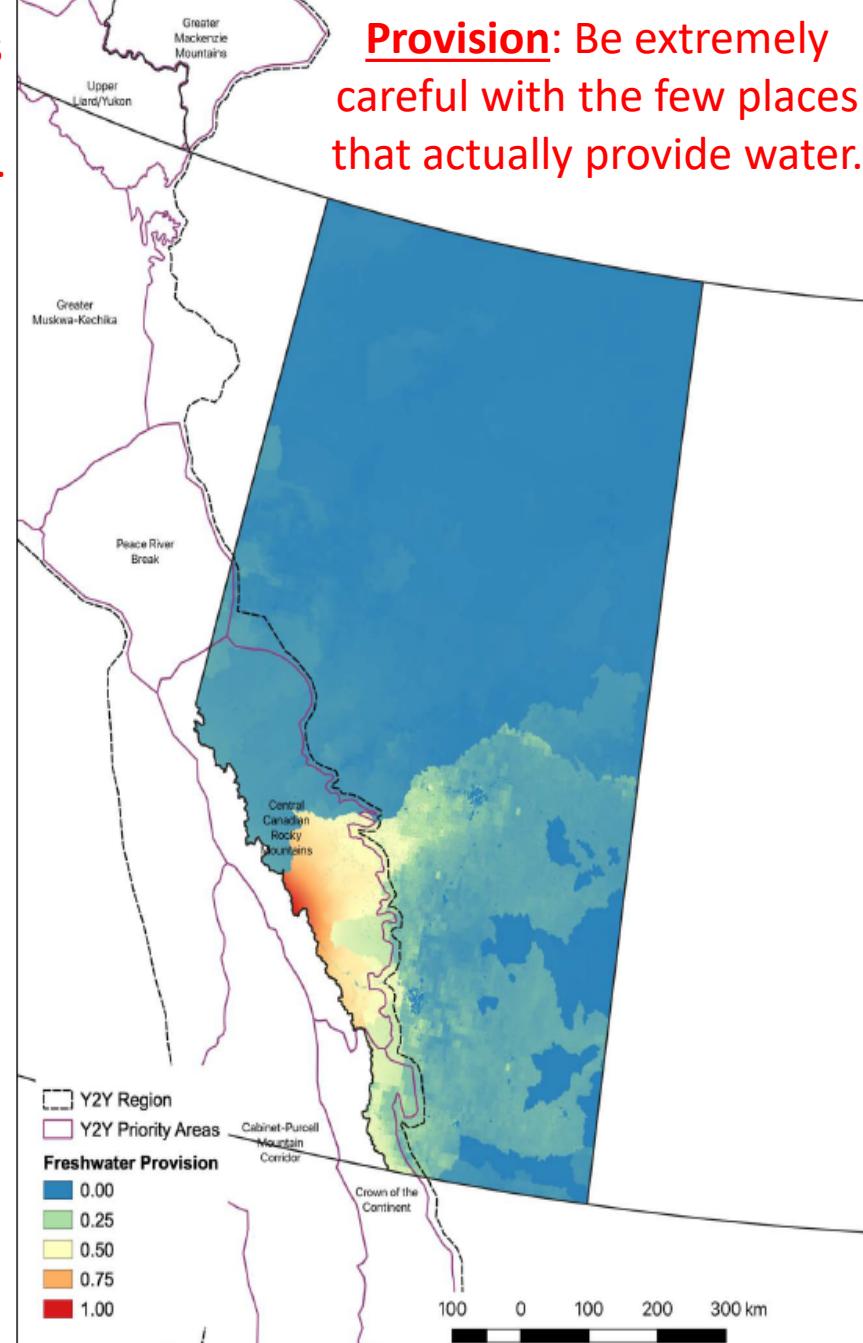
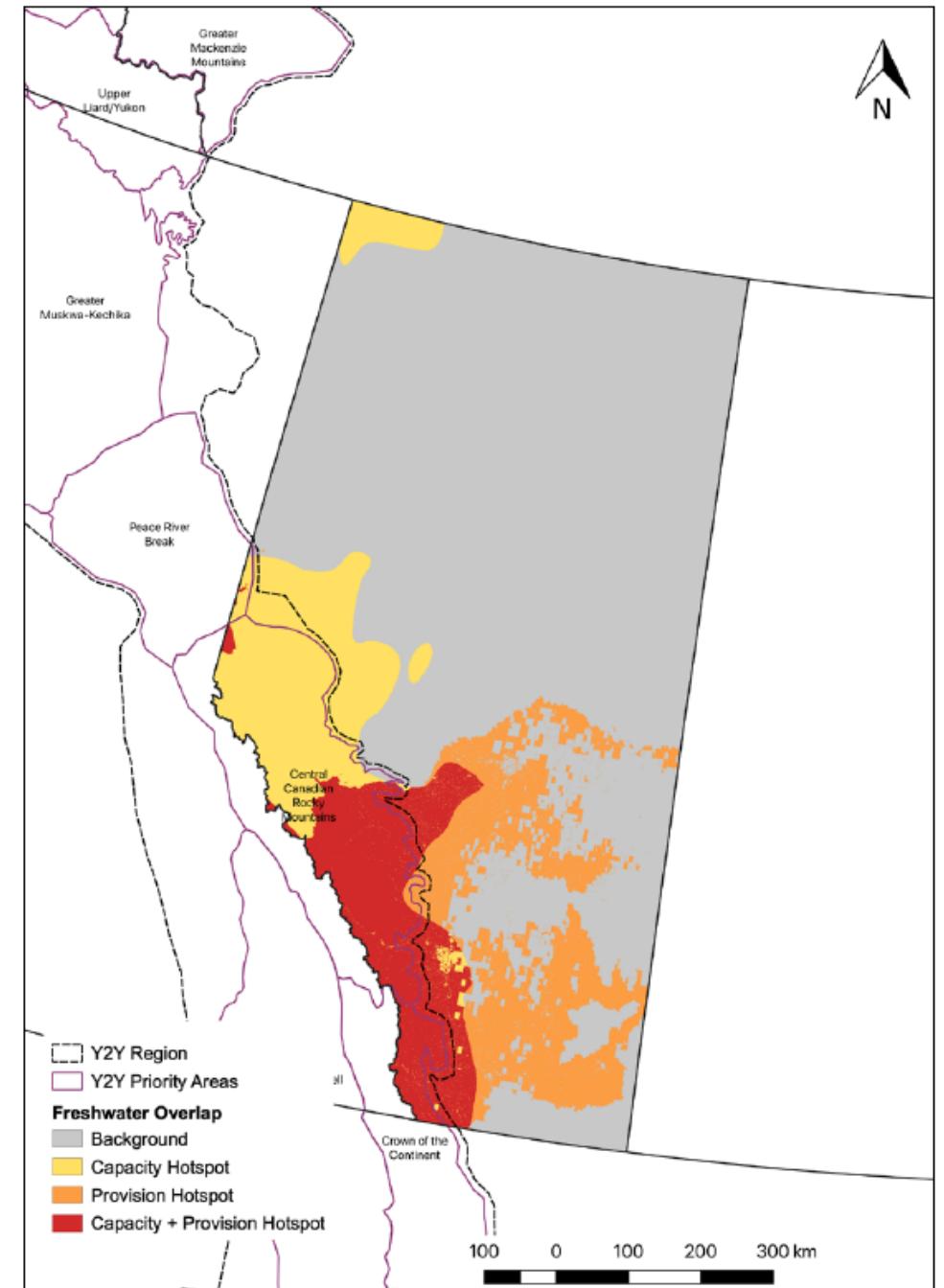


Figure 26. Freshwater provision importance in Alberta.

Across all of Alberta, the most important places for the **provision** of freshwater to the most people is the Eastern Slopes.



Carbon + water +  
recreation (**capacity**):  
Eastern slopes have  
high combined supply.

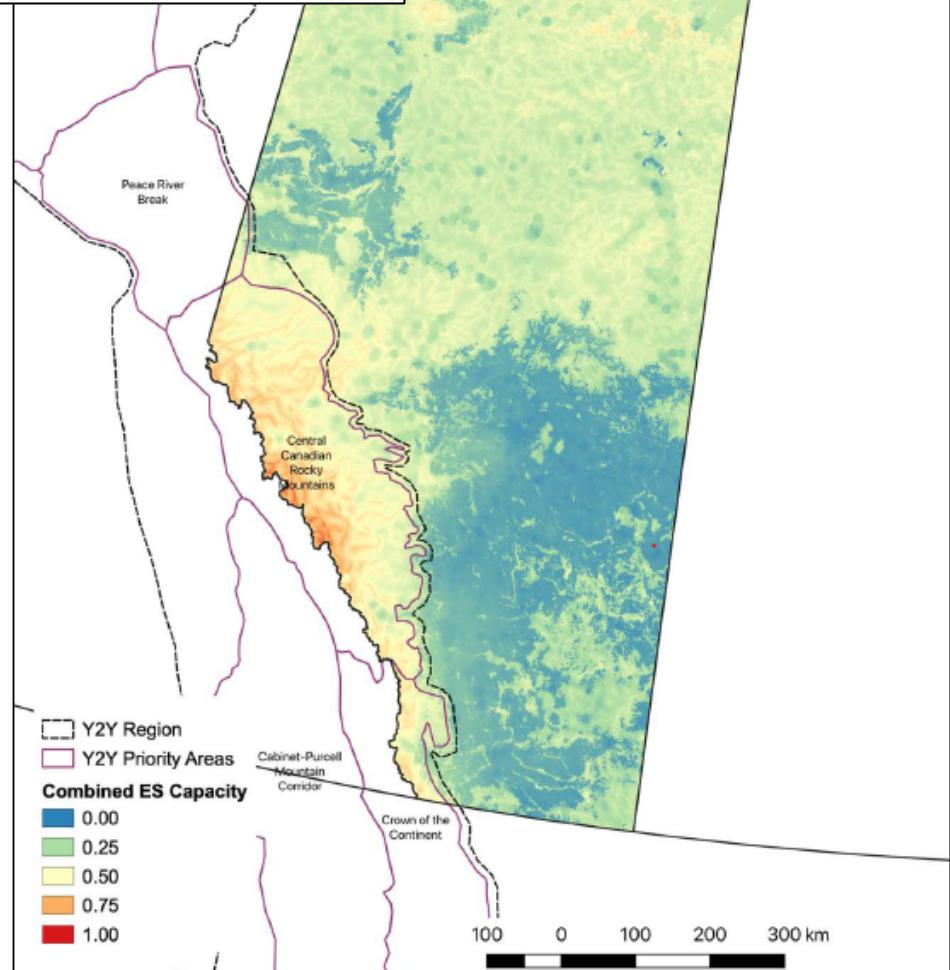


Figure 62. Combined ecosystem service capacity importance in Alberta.

Carbon + water + recreation (**provision**): Eastern Slopes are where people actually get multiple benefits.

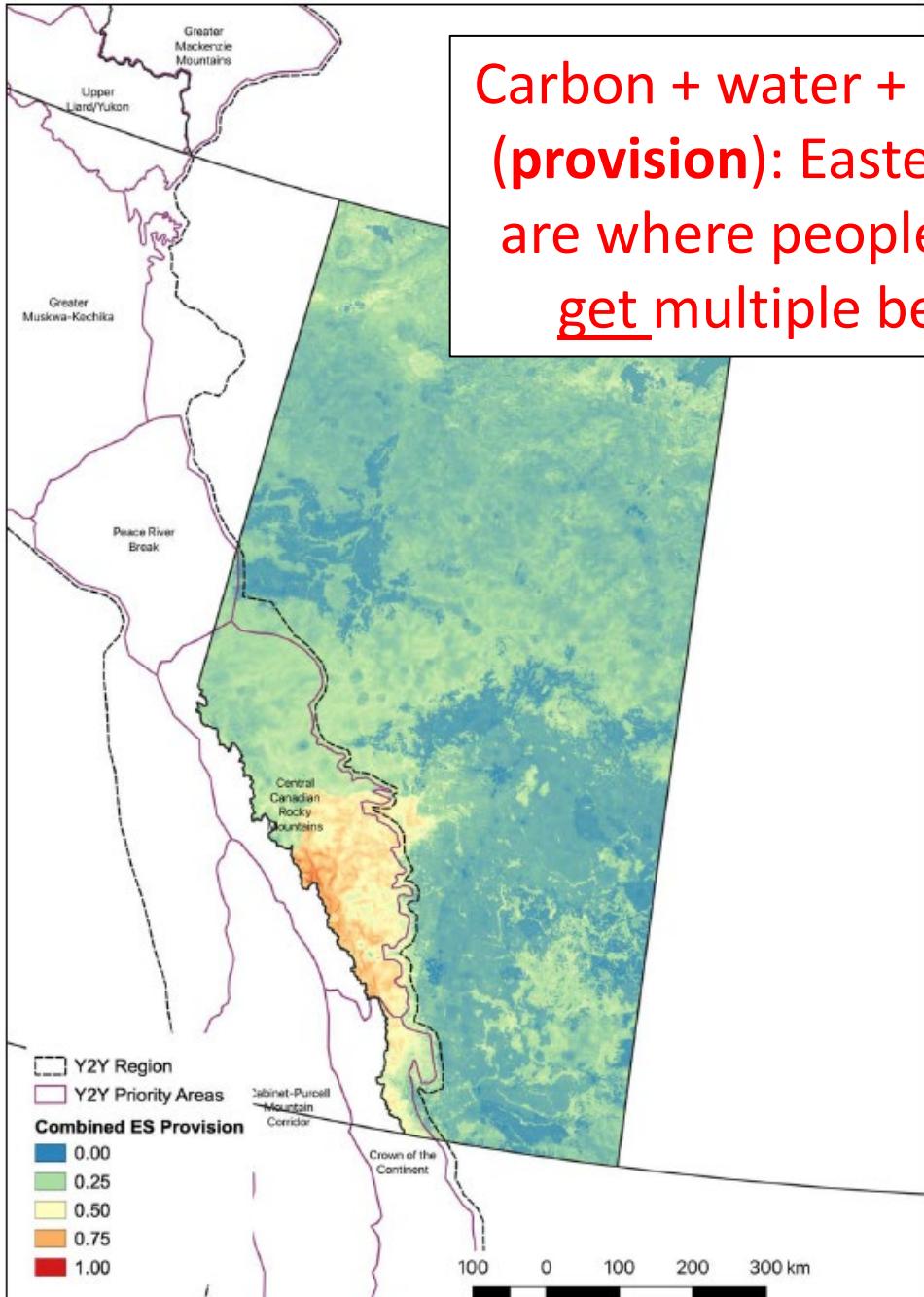


Figure 63. Combined ecosystem service provision importance in Alberta.

Across all of Alberta, the most important places for the **combined provision** of carbon storage, freshwater, and recreation to people is the Eastern Slopes.

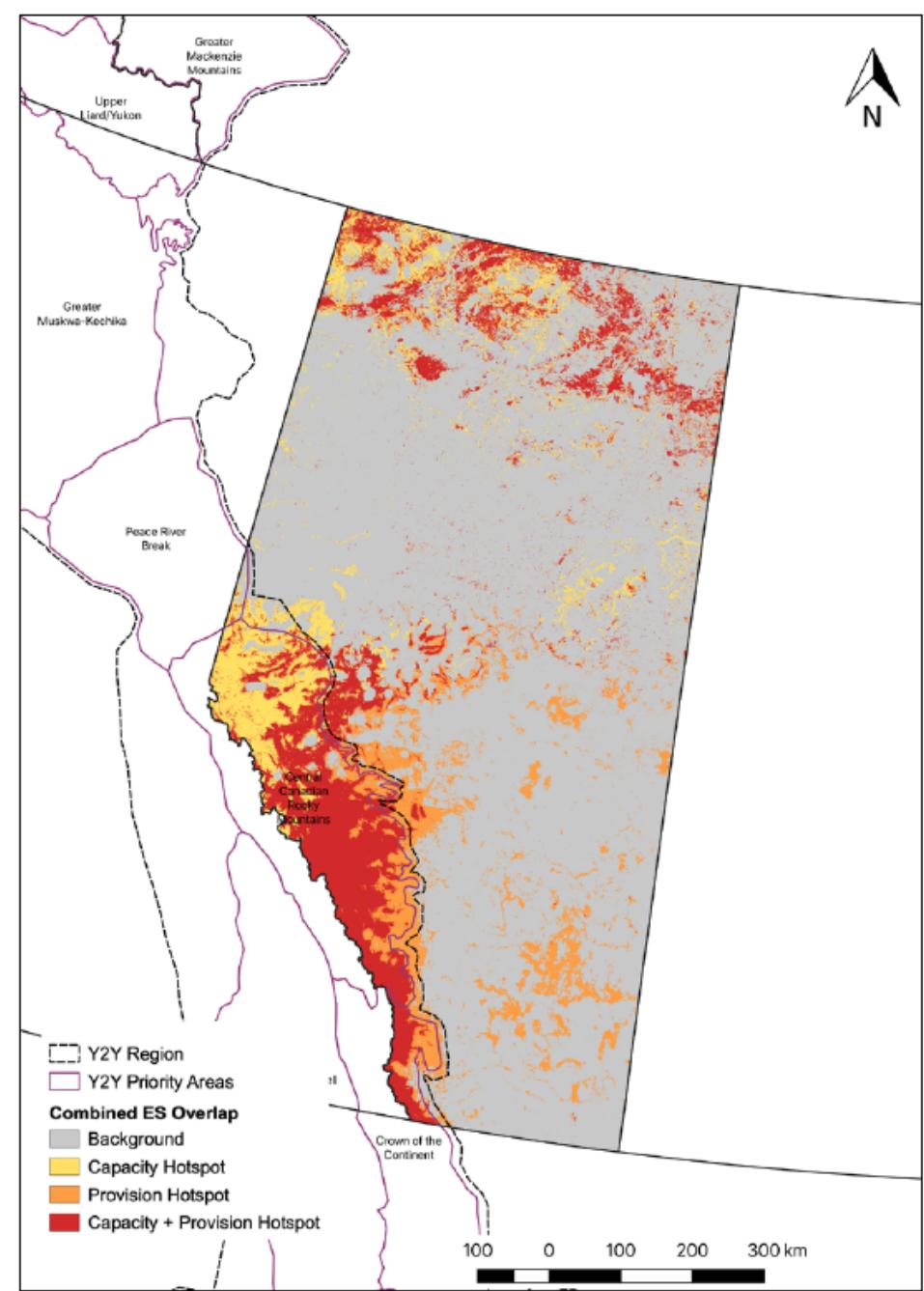


Figure 64. Combined ecosystem service provision hotspots (top 20<sup>th</sup> percentile of values) and overlap in Alberta.

# EXTRA SLIDES

(about methods, if needed)

ENVIRONMENTAL RESEARCH LETTERS  
LETTERS

OPEN ACCESS

LETTER  
Identifying key ecosystem service providing areas to inform national-scale conservation planningMatthew G E Mitchell<sup>1</sup> , Richard Schuster<sup>2</sup> , Aerin L Jacob<sup>3</sup> , Dalal E L Hanna<sup>4</sup> , Camille Ouellet Dallaire<sup>5</sup> , Cara Raudsepp-Hearne<sup>6</sup> , Elena M Bennett<sup>7</sup> , Bernhard Lehner<sup>8</sup> , and Kai M A Chan<sup>9</sup> <sup>1</sup> Institute for Resources, Environment and Sustainability, University of British Columbia, 429-2282 Main Mall, Vancouver, British Columbia V6T 1Z4, Canada<sup>2</sup> Faculty of Land and Food Systems, University of British Columbia, 248-2357 Main Mall, Vancouver, British Columbia V6T 1Z6, Canada<sup>3</sup> Department of Biology, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario, Canada, K1S 5B6<sup>4</sup> Willowtree to Yukon Conservation Initiative, 200-1350 Raybuck Avenue, Canmore, Alberta, Canada, T1W 1P6<sup>5</sup> Department of Natural Resource Sciences, McGill University, 2111 Lakeshore Road, Sainte-Anne-de-Bellevue, Quebec, H9X 3V9 Canada<sup>6</sup> Department of Geography, McGill University, 805 Sherbrooke Street West, Montreal, Quebec, H3A 0B9 Canada<sup>7</sup> Sustainability Science Lab, McGill University, 845 Sherbrooke Street West, Montreal, Quebec, H3A 0G4 Canada<sup>8</sup> Bader School of Environment, McGill University, 2111 Lakeshore Road, Sainte-Anne-de-Bellevue, Quebec H9X 3V9, Canada<sup>9</sup> E-mail: matthew.mitchell@ubc.caOriginal content from this week may be used under the terms of the Creative Commons Attribution License.  
Any further distribution of this work must include a reference to the author(s) and the title of the work, journal citation and DOI.

Keywords: ecosystem services, conservation, protected areas, carbon, hotspot, recreation, Canada

Supplementary material for this article is available [online](#)

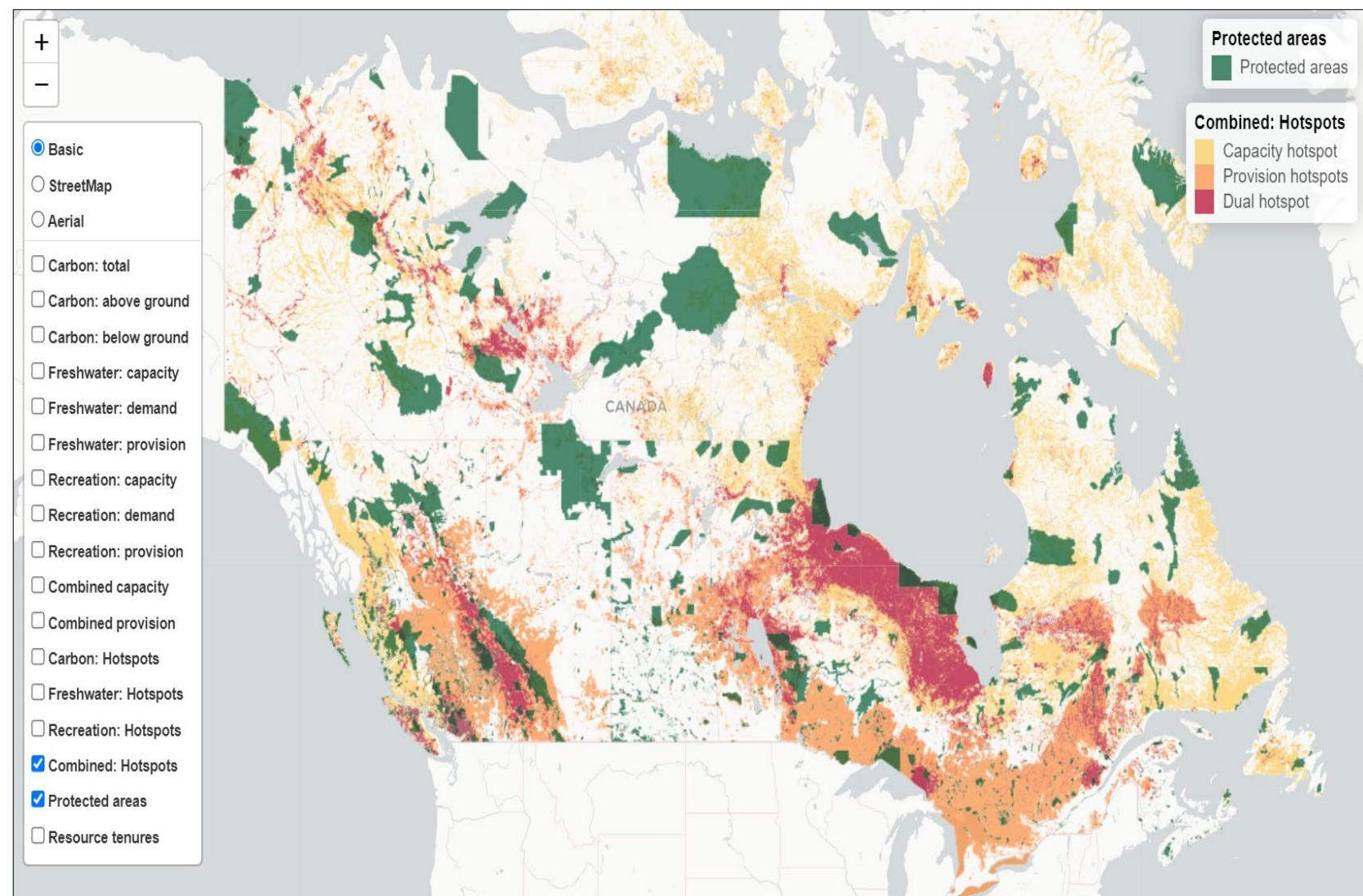
## Abstract

Effectively conserving ecosystem services in order to maintain human wellbeing is a global need that requires an understanding of where ecosystem services are produced by ecosystems and where people benefit from these services. However, approaches to effectively identify key locations that have the capacity to supply ecosystem services and actually contribute to meeting human demand for those services are lacking at broad spatial scales. We developed new methods that integrate measures of the capacity of ecosystems to provide services with indicators of human demand and ability to access these services. We then identified important areas for three ecosystem services currently central to protected area management in Canada—carbon storage, freshwater, and nature-based recreation—and evaluated how these hotspots align with Canada's current protected areas and resource development tenures. We find that locations of ecosystem service capacity overlap only weakly (27–36%) with actual service providing areas (incorporating human access and demand). Overlapping hotspots of provision for multiple ecosystem services are also extremely limited across Canada; only 1.2% (~56 000 km<sup>2</sup>) of the total ecosystem service hotspot area in Canada consists of overlap between all three ecosystem services. Canada's current protected area network also targets service capacity to a greater degree than provision. Finally, one-half to two-thirds of current ecosystem service hotspots (54–66%) overlap with current and planned resource extraction activities. Our analysis demonstrates how to identify areas where conservation and ecosystem service management actions should be focused to more effectively target ecosystem services to ensure that critical areas for ecosystem services that directly benefit people are conserved. Further development of these methods at national scales to assess ecosystem service capacity and demand and integrate this with conventional biodiversity and conservation planning information will help ensure that both biodiversity and ecosystem services are effectively safeguarded.

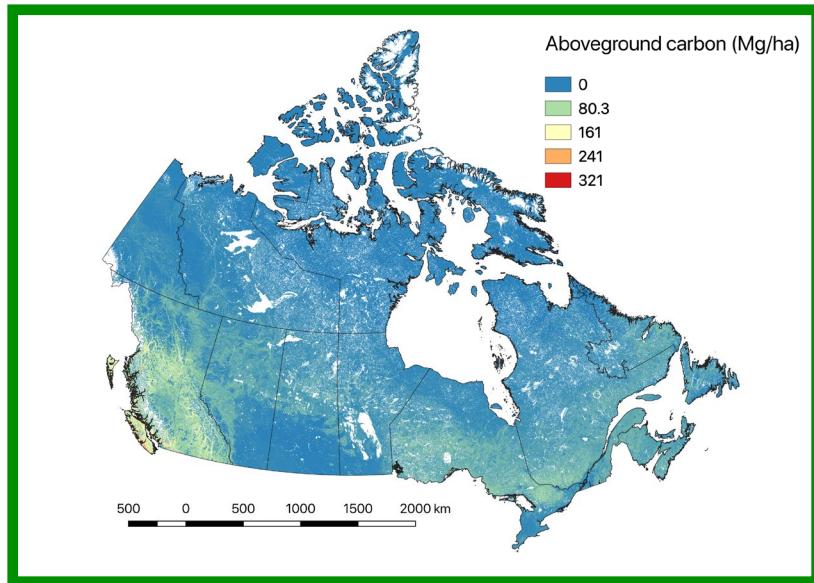
## 1. Introduction

There is an urgent and growing need worldwide to conserve ecosystem services, and a substantial opportunity to achieve this by ensuring that conservation actions target both biodiversity and ecosystem services. The 2050 vision of the Convention on Biological Diversity (CBD 2010) and the 2020 Aichi

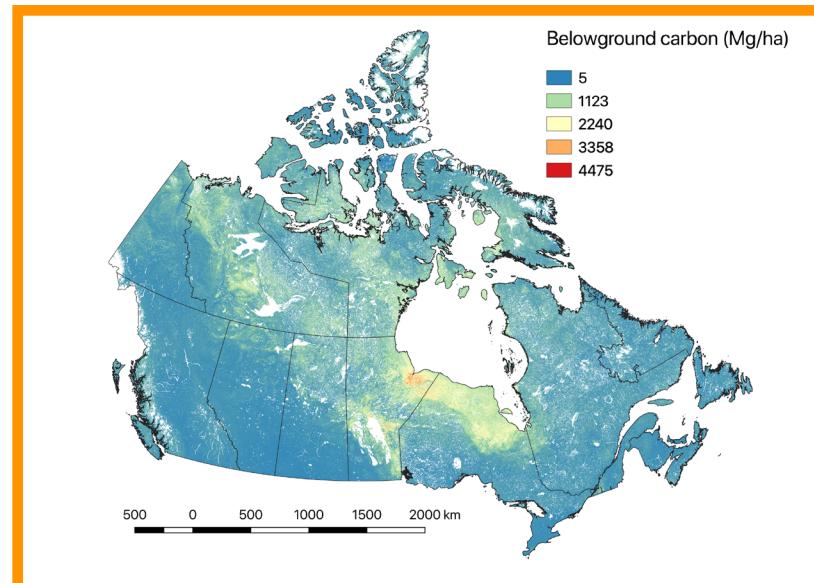
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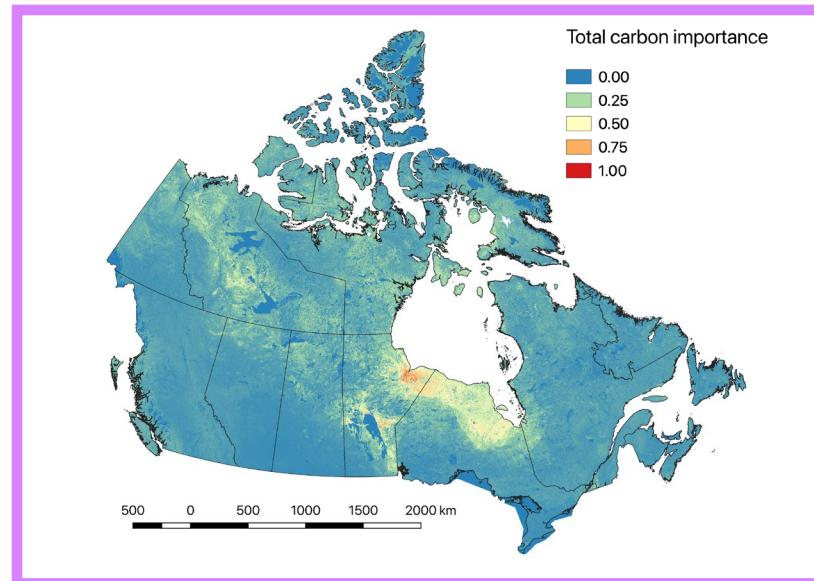
# CARBON: ABOVEGROUND + BELOWGROUND = PROVISION



+



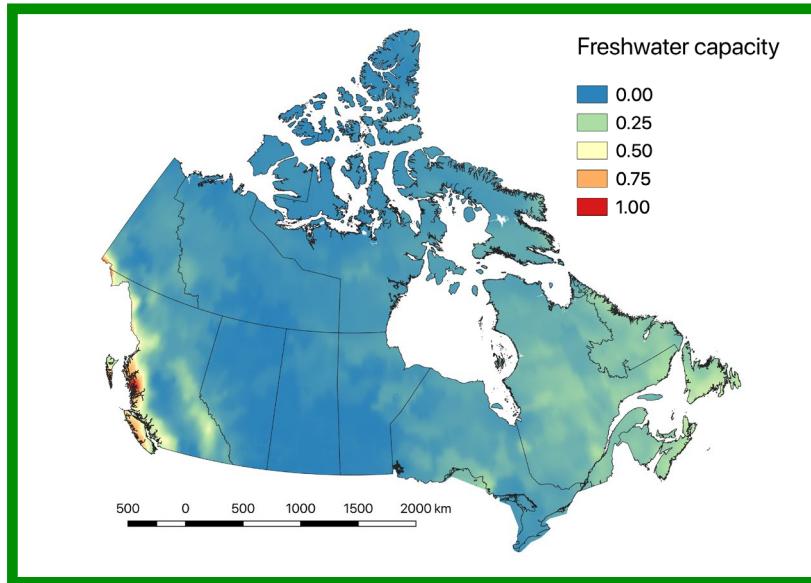
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Provision

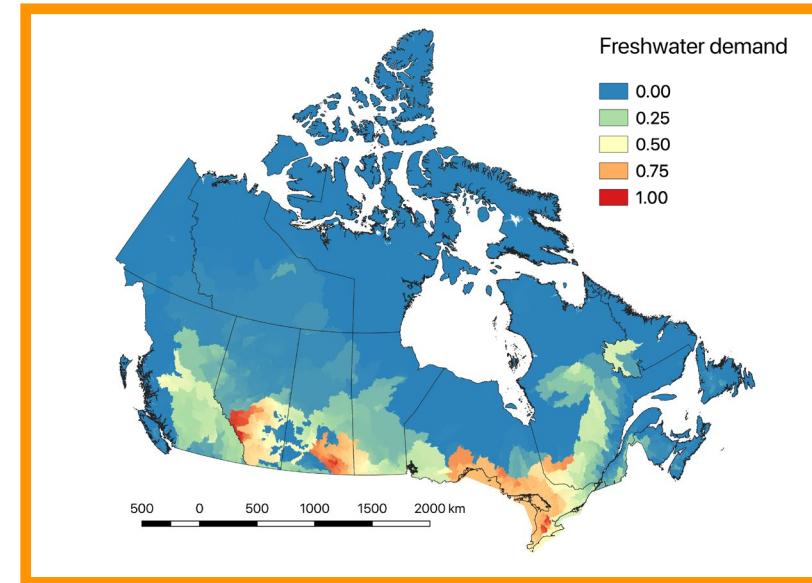
- Aboveground + Belowground
- No need to include demand or flow

# WATER: CAPACITY $\times$ DEMAND = PROVISION



Freshwater capacity

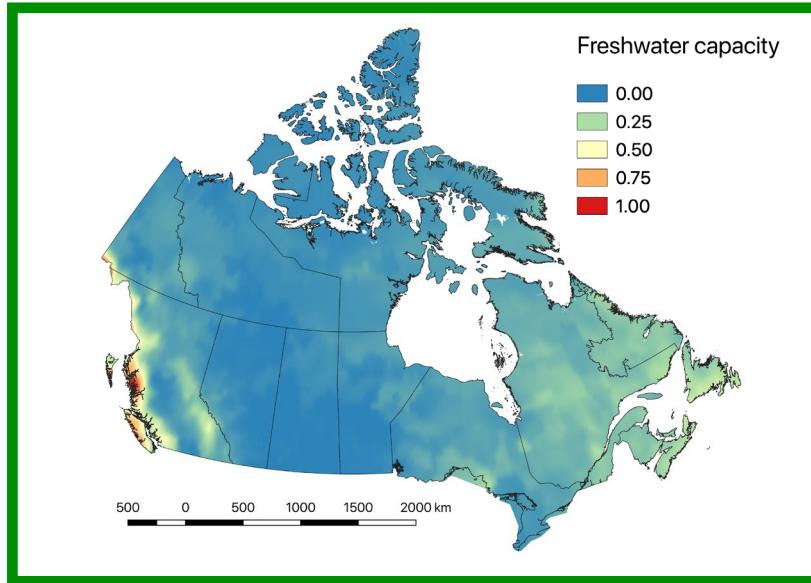
- Estimated water runoff
- HydroSHEDS data
- Estimated from WaterGAP hydrological model



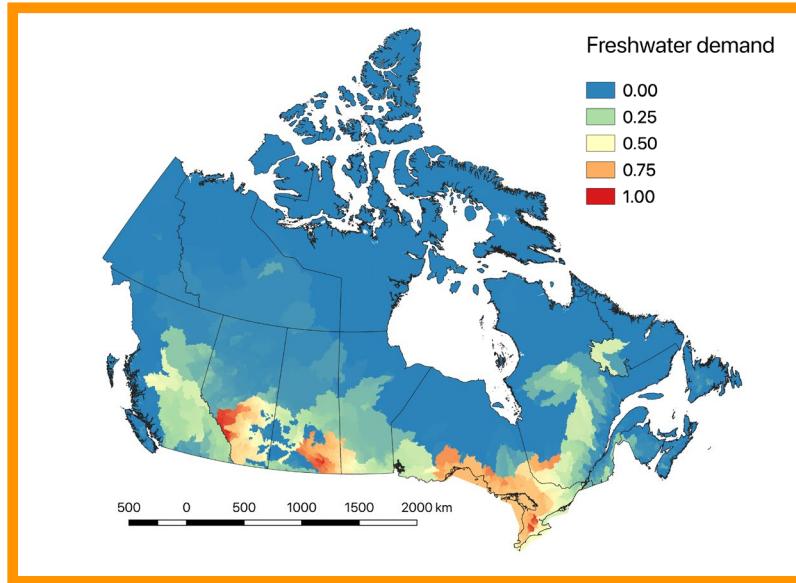
Freshwater demand

- Relative downstream demand
  - area of agricultural land
  - # of dams
  - # of settlements > 100 people
  - # industrial facilities and thermal power stations

# WATER: CAPACITY $\times$ DEMAND = PROVISION



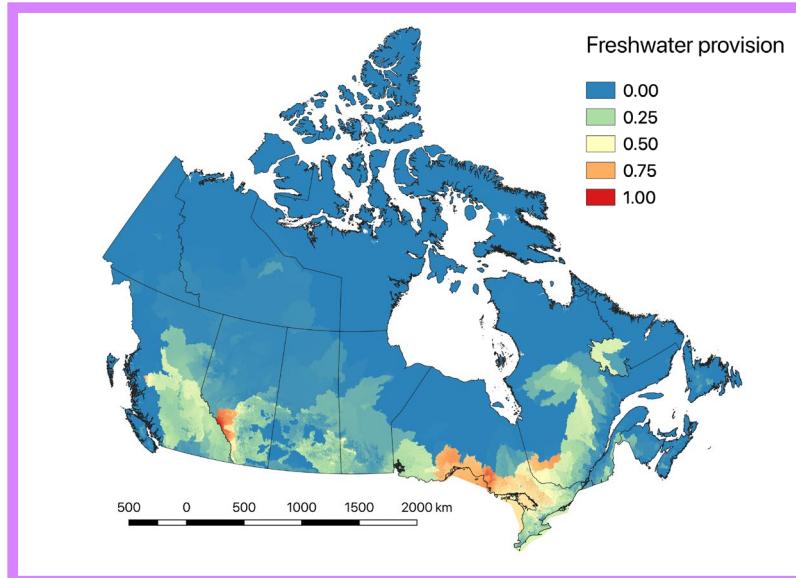
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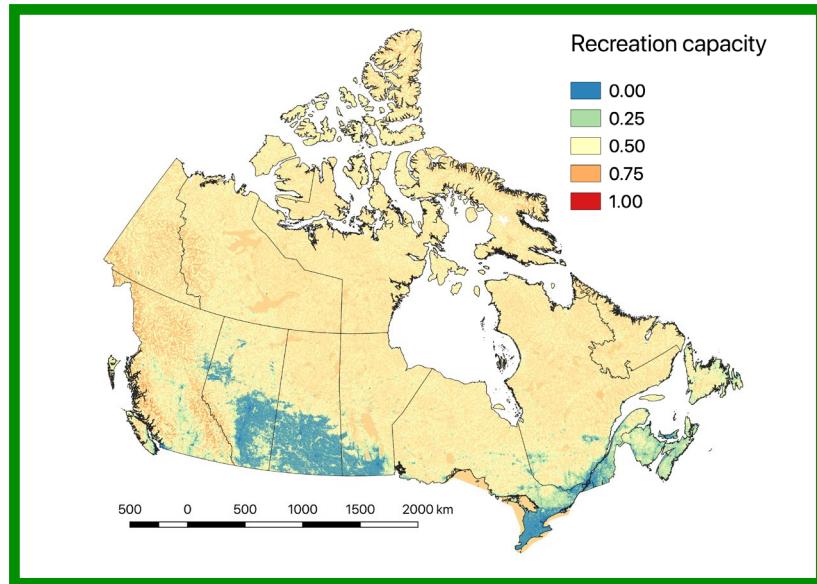
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## Freshwater provision

- Combination of capacity and demand
- Reduced for urban & agricultural areas
- Weighted towards water demand



# RECREATION: CAPACITY $\times$ ACCESS = PROVISION



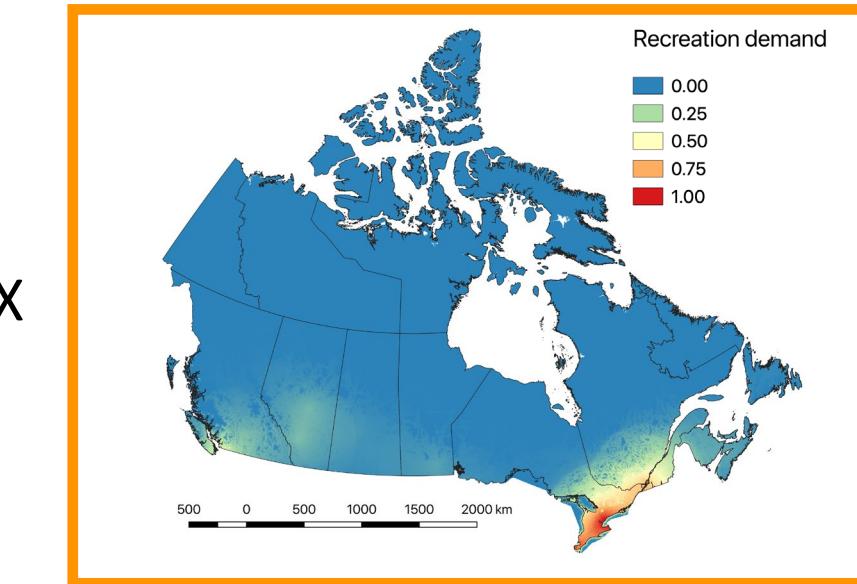
Nature-based recreation capacity

## Positive

- Land cover naturalness
- Proximity to water
- Mountains/ruggedness

## Negative

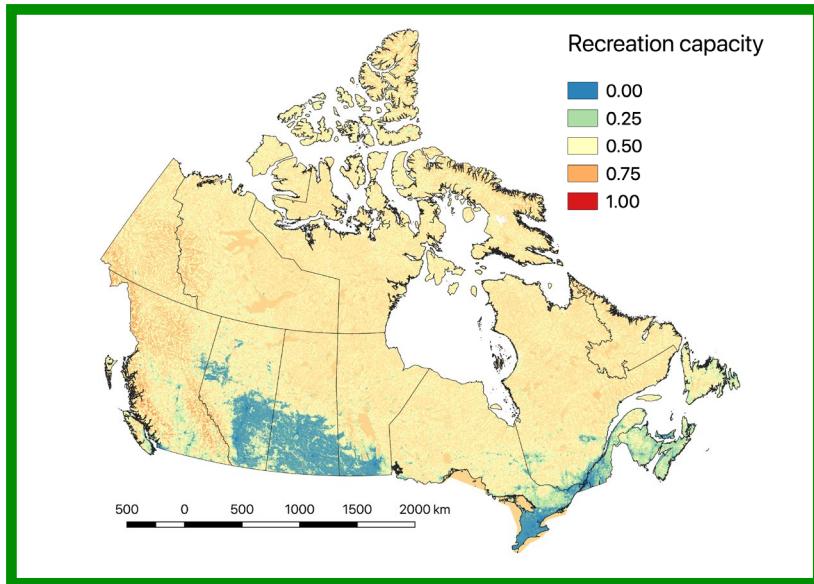
- Road density
- Population density



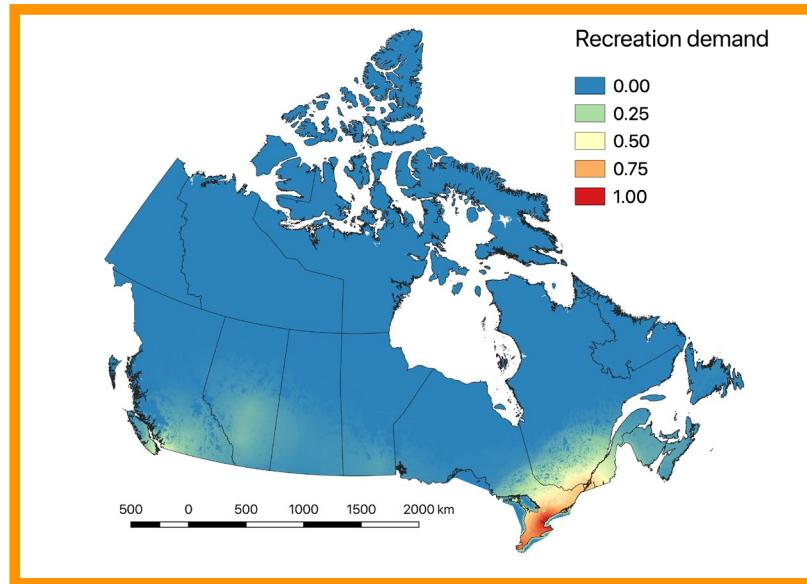
Nature-based recreation access/demand

- Distance to road within 5 km
- Population density within 500 km (including US populations)

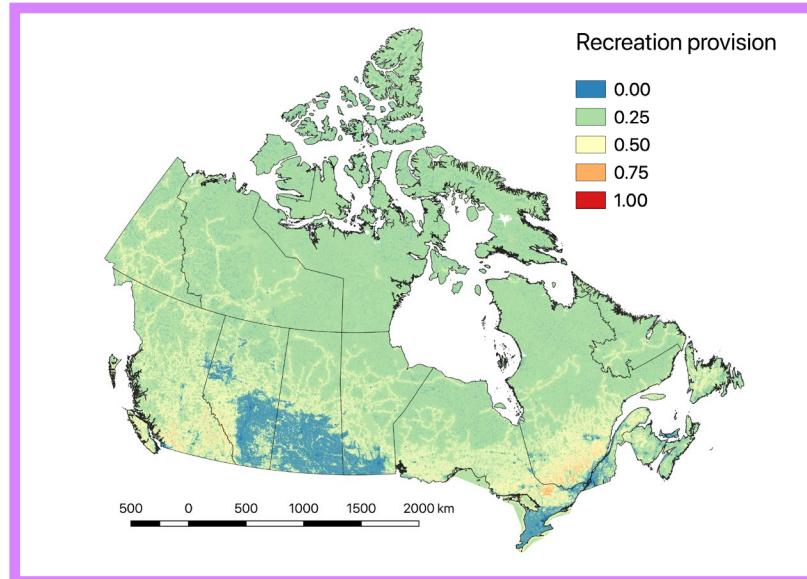
# RECREATION: CAPACITY $\times$ ACCESS = PROVISION



$\times$



=



## Nature-based recreation provision

- Combination of capacity & access/demand
- Weighted towards areas with high capacity but low access/demand